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SEMICONDUCTOR MANUFACTURING DEVICE AND SEMICONDUCTOR DEVICE MANUFACTURING METHOD

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SEMICONDUCTOR MANUFACTURING DEVICE AND SEMICONDUCTOR DEVICE MANUFACTURING METHOD

[Handotai seizo sochi oyobi handotai sochi no seizo hoho]

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[There are no amendments to this patent.]

Claims /2*

1. Semiconductor manufacturing device furnished with: a vaporizing part that has a vaporizer that generates a source gas obtained by vaporizing a source liquid material,

a reaction chamber in which the semiconductor device manufacturing process is executed by reaction processing using the aforementioned source gas,

and a control part that controls the device components, including the aforementioned vaporizing part;

* [Numbers in the right margin indicate pagination of the foreign text.]

and where the aforementioned control part executes forced vaporization processing to forcibly vaporize the aforementioned source liquid material in the aforementioned vaporizer after the period during which the aforementioned vaporizer has not generated the aforementioned source gas has reached a prescribed time.

2. A semiconductor manufacturing device that is the semiconductor manufacturing device mentioned in Claim 1,

where the aforementioned vaporizer has a first carrier gas introduction path by which a first carrier gas can be introduced into the aforementioned vaporizer,

and the aforementioned forced vaporization processing includes processing wherein the aforementioned source liquid material is vaporized to generate the aforementioned source gas by introducing the aforementioned first carrier gas through the aforementioned first carrier gas introduction path.

3. A semiconductor manufacturing device that is the semiconductor manufacturing device mentioned in Claim 1,

where the aforementioned vaporizer has a source liquid material path for introducing the aforementioned source liquid material into the inside,

the aforementioned vaporizing part has a second carrier gas introduction path by which a second carrier gas can be introduced into the aforementioned source liquid material path of the aforementioned vaporizer from outside the aforementioned vaporizer,

and the aforementioned forced vaporization processing includes processing wherein the source liquid material present in the aforementioned source liquid material path is discharged outside the aforementioned vaporizer while being vaporized by introducing the aforementioned second carrier through the aforementioned second carrier gas introduction path.

4. A semiconductor manufacturing device that is the semiconductor manufacturing device mentioned in Claim 3,

where the aforementioned vaporizing part has, in addition, a cleaning material introduction path by which cleaning material for the aforementioned source liquid material can be introduced into the aforementioned source liquid material path,

and the aforementioned control part further executes source liquid material cleaning processing to clean the aforementioned source liquid material remaining in the aforementioned source liquid material path by introducing the aforementioned cleaning material through the aforementioned cleaning material introduction path after the aforementioned forced vaporization processing has been executed.

5. A semiconductor manufacturing device that is the semiconductor manufacturing device mentioned in Claim 4,

where the aforementioned control part controls so that the aforementioned source liquid material that is vaporized when the aforementioned forced vaporization processing is executed is discharged to a first discharge part, and the aforementioned cleaning material is discharged to a second discharge part when the aforementioned source liquid material cleaning processing is executed.

6. A semiconductor manufacturing device that is the semiconductor manufacturing device mentioned in Claim 4 or 5,

where the aforementioned cleaning material includes a cleaning material in the form of a liquid,

and the aforementioned control part will further execute processing to discharge the aforementioned cleaning material outside the aforementioned vaporizer while it is being vaporized by setting the temperature of the aforementioned vaporizer to a temperature at or above the boiling point of the aforementioned cleaning material and by introducing a second carrier gas through the aforementioned second carrier gas introduction path after the aforementioned source liquid material cleaning processing has been executed.

7. A semiconductor device manufacturing method that uses the semiconductor manufacturing device mentioned in any one of Claims 1 through 6 and that executes the aforementioned semiconductor device manufacturing processes in the aforementioned reaction chamber to manufacture semiconductor devices.

Detailed explanation of the invention

[0001]

Technical field of the invention

This invention relates to a semiconductor manufacturing device. It relates in particular to a vapor phase growth device that reacts ozone and an organic source gas along with CVD to form an oxide film on a substrate surface.

[0002]

Prior art

Figure 8 is a block diagram that shows the constitution of a conventional vapor phase growth device (film forming device). A vapor phase growth device is a device for reacting ozone and an organic source gas to form an oxide film on a substrate by CVD. Below, a conventional vapor phase growth device that uses CVD will be explained by referring to Figure 8.

[0003]

As shown in the figure, TEOS (Tetraethoxysilane: $Si(OC_2H_5)_4$)), TMPO (Trimethyl Phosphate: $PO(OCH_3)_3$), and TEB (Triethyl Borate: $B(OC_2H_5)_3$), which are three types of organic sources (source liquid material), are provided to vaporizers (generators) (20)-(22) through liquid flow rate meters (LMFM: liquid mass flow meter) (26), (27) and (28), respectively. In this case, the flow rate of each source liquid material (TEOS, TMPO, TEB) is controlled by controlling a gap in valves (not shown in Figure 8) mounted on each vaporizer (20), (21) and (22) based on the values measured by liquid flow rate meters (26)-(28). Source liquid material vaporizing unit (63) is constituted by vaporizers (20)-(22) and liquid flow rate meters (26)-(28).

[0004]

Vaporizers (20)-(22) use a direct vaporizing system. By feeding the source liquid material into a small gap in the vaporizer that is kept at a high temperature (around 150°C) and also supplying a carrier gas, the source liquid material is instantly vaporized (flash vaporization) at the open end of the small gap.

[0005]

Each source liquid material is vaporized inside the corresponding vaporizer (20)-(22) as described above. The source gas obtained by vaporizing each source liquid material in vaporizers (20)-(22) is introduced into reaction chamber (1) using N_2, with its flow rates regulated by flow rate regulators (MFC: mass flow controller) (23)-(25) of gas feed unit (62), as the carrier gas (at this time, valves (7) and (9) are "closed" and valve (8) is "open").

[0006]

Note that the output ends of vaporizers (20)-(22) are each connected to piping (16), and /3
piping (16) is connected to the input end of valve (8) (source gas feed valve). Piping (17) that is connected to reaction chamber (1) is connected to the output end of valve (8). Piping (18), that constitutes the path to waste liquid tank (10), is connected to piping (16) through valve (7) (discharge valve), and piping (19), that constitutes a path to flow regulator (14), is connected to piping (17) through valve (9) (inert gas feed valve). Note that flow rate regulator (14) is for regulating the flow rate of N_2 gas introduced into reaction chamber (1) as purge gas.

[0007]

On the other hand, O_2 and N_2, with flow rates regulated by flow rate regulators (4) and (5) inside gas feed unit (62), are introduced to ozone generator (2) as ozone raw material gas, and ozone is generated by ozone generator (2). Ozone generator (2) is constituted to generate ozone by

electrical discharge in an oxygen atmosphere and has a high voltage power source and a discharge cell for electrical discharge.

[0008]

Because ozone is harmful, in cases where the ozone introduction path is open, it is exhausted after it passes through ozone processor (15) with valve (11) "open." Ozone processor (15) may adsorb ozone with activated carbon, etc.

[0009]

The internal pressure in ozone generator (2) is controlled at a prescribed value by automatic pressure regulator (APC: automatic pressure controller) (6). For the ozone generated from ozone generator (2), its (ozone) concentration is monitored by ozone monitor (3), and it is introduced into reaction chamber (1) with N_2, at a flow rate regulated by flow rate regulator (13), as the carrier (at this time valve (11) is "closed" and valve (12) is "open").

[0010]

Here, the ozone gas vaporized by vaporizers (20)-(22) is introduced into reaction chamber (1) with valve (7) "closed" and valve (8) "open," after dummy vaporization processing has been executed to exhaust for a fixed time to waste liquid tank (10) with valve (8) "closed" and valve (7) "open" to ensure an initial stabilization time.

[0011]

A BPTEOS film is formed on a semiconductor wafer (not shown in Figure 8) placed in reaction chamber (1) by the chemical reaction between the TEOS, TMPO and TEB, and the ozone introduced into reaction chamber (1) as described above.

[0012]

Figure 9 is a cross section that shows the internal constitution of each vaporizer (20)-(22). As shown in the figure, N_2, which is the carrier, is introduced through carrier N_2 inlet (39). On the other hand, source liquid material is fed through source liquid material channel (41), and control of the flow rate is accomplished by controlling gap (43) with valve (42). By introducing N_2 while the source liquid material is heated by heater (44), the source gas obtained by vaporizing the source liquid material is discharged through source gas outlet (40) with N_2 as the carrier.

[0013]

Problems to be solved by the invention

Figure 10 is a graph that shows the status of the vaporizers shown in Figure 9. In Figure 10 the horizontal axis represents elapsed time and the vertical axis represents the status of the vaporizer. The piping furnished for the vaporizers and source gas outlet (40) of the vaporizers must be kept at a prescribed high temperature to prevent re-liquefaction of the source liquid material. In addition, to raise and lower the temperature of this system (piping furnished for the vaporizers and source gas outlet (40) of the vaporizers), several hours are necessary, taking into account stabilization time.

[0014]

Therefore, after power to device main unit (61) is turned on, a high temperature must be maintained regardless of whether or not there vaporization of the source liquid material is occurring. That is, with source liquid material vaporizing unit (63) of a conventional vapor phase growth device, when reaction processing is not executed for a product, e.g., a wafer, placed in reaction chamber (1), the source liquid material present in source liquid material channel (41) of the vaporizer is kept at a high temperature.

[0015]

The moisture present in the source liquid material, particularly TMPO, gradually hydrolyzes the material. According to data obtained in 1999, the moisture concentration is around 5-100 ppm. Figure 11 is a graph that shows the relationship with the concentration of oligomers (polymers, obtained by TMPO hydrolyzing) when TMPO remains at high temperature. As shown in this figure, as the time at high temperature increases, the oligomer concentration also rises.

[0016]

In the vaporizer shown in Figure 9, valve (42) is normally controlled so that gap (43) will be several tens of μm. Therefore, when TMPO hydrolyzes and polymerizes and solidifies inside gap (43), this leads to a drop in vaporizing efficiency by the vaporizer. In the worst case, the vaporizer will become blocked and unusable, which has been a problem.

[0017]

This invention was devised to solve the aforementioned problems. Its objective is to obtain a semiconductor manufacturing device that has a vaporizer that will not cause difficulties even when left at a high temperature.

[0018]

Means to solve the problems

The semiconductor manufacturing device mentioned in Claim 1 in this invention is furnished with a vaporizing part that has a vaporizer that generates a source gas obtained by vaporizing a source liquid material, a reaction chamber in which the semiconductor device manufacturing process is executed by reaction processing using the aforementioned source gas, and a control part that controls the device components, including the aforementioned vaporizing part. The aforementioned control part executes forced vaporizing processing to forcibly vaporize the aforementioned source liquid material inside the aforementioned vaporizer after the period for which the aforementioned vaporizer has not generated the aforementioned source gas has reached a prescribed time.

[0019]

And the invention in Claim 2 is the semiconductor manufacturing device mentioned in Claim 1. The aforementioned vaporizing part has a first carrier gas introduction path by which a first carrier gas can be introduced into the aforementioned vaporizer. The aforementioned forced vaporizing processing includes processing to generate the aforementioned source gas by vaporizing the aforementioned source liquid material by introducing the aforementioned first carrier gas through the aforementioned first carrier gas introduction path.

[0020] /4

And the invention in Claim 3 is the semiconductor manufacturing device mentioned in Claim 1. The aforementioned vaporizer has a source liquid material channel through which the aforementioned source liquid material flows into the inside. The aforementioned vaporizing part has a second carrier gas introduction path by which a second carrier gas can be introduced into the aforementioned source liquid material channel of the aforementioned vaporizer from outside the aforementioned vaporizer. The aforementioned forced vaporizing processing includes processing for discharging the source liquid material present in the aforementioned source liquid material channel outside the aforementioned vaporizer while it is being vaporized by introducing the aforementioned second carrier gas through the aforementioned second carrier gas introduction path.

[0021]

And the invention in Claim 4 is the semiconductor manufacturing device mentioned in Claim 3. The aforementioned vaporizing part has, in addition, a cleaning material introduction path by which cleaning material for the aforementioned source liquid material can be introduced

into the aforementioned source liquid material path. The aforementioned control part further executes source liquid material cleaning processing to clean the aforementioned source liquid material remaining in the aforementioned source liquid material channel by introducing the aforementioned cleaning material through the aforementioned cleaning material introduction path after the aforementioned forced vaporizing processing has been executed.

[0022]

And the invention in Claim 5 is the semiconductor manufacturing device mentioned in Claim 4. The aforementioned control part controls so that the aforementioned source liquid material that is vaporized when the aforementioned forced vaporizing processing is executed will be discharged into a first discharge part, and the aforementioned cleaning material will be discharged into a second discharge part when the aforementioned source liquid material cleaning processing is executed.

[0023]

And the invention in Claim 6 is the semiconductor manufacturing device mentioned in Claim 4 or 5. The aforementioned cleaning material includes a cleaning material in the form of a liquid. The aforementioned control part will further execute processing to discharge the aforementioned cleaning material outside the aforementioned vaporizer while it is being vaporized by setting the temperature of the aforementioned vaporizer to a temperature at or above the boiling point of the aforementioned cleaning material and by introducing a second carrier gas through the aforementioned second carrier gas introduction path after the aforementioned source liquid material cleaning processing has been executed.

[0024]

The semiconductor device manufacturing method mentioned in Claim 7 that pertains to this invention will use the semiconductor manufacturing device mentioned in any one of Claims 1 through 6 and will execute the aforementioned semiconductor device manufacturing processes in the aforementioned reaction chamber to manufacture semiconductor devices.

[0025]

Embodiments of the invention

Embodiment 1

Figure 1 is a block diagram that shows the constitution of a vapor phase growth device which is Embodiment 1 of this invention. As shown in the figure, TEOS, TMPO and TEB, which are three types of organic sources (source liquid material) are provided to vaporizers (20)-(22)

through liquid flow rate meters (26), (27) and (28), respectively. In this case, the flow rate of each source liquid material (TEOS, TMPO, TEB) is controlled by controlling a gap in a valve (not shown in Figure 1) mounted in each vaporizer (20), (21) and (22) based on the values measured by liquid flow rate meters (26)-(28).

[0026]

Then each source liquid material is vaporized in the corresponding vaporizer (20)-(22). The source gas, from each source liquid material being vaporized inside vaporizers (20)-(22) is introduced into reaction chamber (1) through flow rate meters (29)-(31) and piping (16) and (17) with N_2 at a flow rate regulated by flow rate regulators (23)-(25) as the carrier (at this time, valve (8) is "open").

[0027]

Flow rate meters (29)-(31) are furnished to measure the flow rate of each source gas. This arrangement will measure in advance the flow rate with only the carrier gas (N_2 gas) flowing without supplying a source gas, and will measure the flow rate of the source gas by subtracting the flow rate of the N_2 gas from the flow rate of the (source gas + N_2 gas) when the source gas is supplied.

[0028]

Device controller (50) is additionally furnished for controlling the components of the device, including vaporizers (20)-(22). Note that, in Figure 1, device controller (50) shows broken-line arrows only to vaporizers (20)-(22), but actually it controls all the components of the device. Otherwise, the constitution is the same as the constitution of the conventional vapor phase growth device shown in Figure 8, so explanation will be omitted.

[0029]

As shown in Figure 9, a heater (44) is embedded inside each vaporizer (20)-(22) to keep [, for example,] the TMPO present in source liquid material channel (41) inside vaporizer (21) in a high-temperature state when it is not vaporized. As shown in the graph in Figure 11, when the time of leaving at high temperature is 8 hours or less, the amount of oligomer generation will be 10 ppm or less. With this level of oligomers, no blockage of the vaporizer is observed. Although dependant on the structure of the vaporizer, the source liquid material in liquid material channel (41) that is held at high temperature is normally 1 cc or less, and it can be discharged satisfactorily by executing dummy vaporizing processing for several minutes (vaporizing the source liquid material

to generate source gas, and sending the gas generated to waste liquid tank (10) (drain side) without introducing it to reaction chamber (1) (chamber)).

[0030]

Figure 2 is a flowchart that shows the control details for the vaporizers (at least vaporizer (21)) by device controller (50). Below, the procedure thereof will be explained by referring to Figure 2. Note that a timer that can clock a counted time is built into device controller (50).

[0031]

First, the timer is stopped at step S1, and after the count time is initialized to "0," whether film formation has been completed is detected at step S2. If detected, [processing] goes to step S3. Here, whether or not film formation has been completed is also possible by detecting the state of reaction chamber 1, or the like.

[0032]

The timer is activated at step S3, and the timer starts to clock the count time from "0." With the example in Figure 3, when film formation completion time (t2) is detected at step S2, this is used as the trigger so that the timer will be activated at step S3.

[0033]

Whether or not film formation has started is checked at step S4. If the start of film formation is detected, [processing] returns to step S1. The timing is stopped at step S1, and after the count time is initialized, processing to detect completion of film formation is again performed at step S2.

[0034]

On the other hand, if the start of film formation is not detected at step S4, [processing] goes to step S5. At step S5, whether or not the timer count time has reached a prescribed time is checked. When the count time has reached the prescribed time, [processing] goes to step S6. If it has not been reached, [processing} returns to step S4.

[0035]

At step S6, which is executed if the count time has reached the prescribed time at step S5, dummy vaporization processing is forcibly executed for the vaporizers. After the count time is initialized at step S7, [processing] returns to step S4.

[0036]

With the example in Figure 3, time (t3) will be the time after a prescribed time has elapsed after time (t2). The vaporizers will be turned on for several minutes at time (t3), dummy vaporization processing will be executed, and they will be turned off. That is, in the case of vaporizer (21), N_2 gas is introduced through flow rate regulator (24) for several minutes from time (t3), and source gas in which TMPO is vaporized will be discharged to waste liquid tank (10) through "open" valve (7) from vaporizer (2) [sic; (21)].

[0037]

The prescribed time, as shown in Figure 11, in cases where oligomer will be generated when a vaporizer is kept at a high temperature, can conceivably be 8 hours (amount of oligomer generation is 10 ppm, which will not adversely affect the vaporizer). That is, if the high temperature state after completion of film formation and before the next film formation is started continues for 8 hours, dummy vaporization processing will be forcibly executed at step S6.

[0038]

On the other hand, if new film formation is started before the timer count time has reached the prescribed time, [processing] returns from step S4 to step S1 and the timer is cleared.

[0039]

Control by device controller (50) shown in Figure 2 is executed continuously while the power to the vapor phase growth device is on.

[0040]

In this way, with the vapor phase growth device of Embodiment 1, dummy vaporization processing will be executed forcibly during the period that the vaporizer is left at high temperature at a stage where the amount of oligomer generation will not adversely affect the vaporizer, under the control of device controller (50). So the adverse effects on vaporizer (21) that accompany oligomer generation from TMPO can be reliably avoided.

[0041]

<u>Embodiment 2</u>

Figure 4 is a block diagram that shows the constitution of TMPO vaporizing part (52A) in a vapor phase growth device which is Embodiment 2 of this invention. As shown in the figure, a purge port composed of fluid regulator (32) and valve (33) is additionally furnished for piping (46) that is connected to the source liquid material channel of vaporizer (21). Along with this, valve

(34) is furnished between fluid flow rate meter (27) and piping (46). Fluid regulator (32) is furnished to feed N_2 gas at a prescribed flow rate. Note that the constitution other than flow rate regulator [sic; vaporizing part] (52A) is the same as the constitution of Embodiment 1 shown in Figure 1.

[0042]

In a constitution such as this, during normal film formation, the processing is performed with a constitution equivalent to the vapor phase growth device of Embodiment 1 with valve (33) "closed" and valve (34) "open." The power for normal vapor phase growth devices is left on even when no semiconductor devices are being manufactured in reaction chamber (1), since time is required for activation. For example, even when manufacturing is not performed for several days, the power to the vapor phase growth device will be on.

[0043]

Then in the same way as described in Embodiment 1, at the point where a prescribed time has elapsed after completion of film formation under the control of device controller (50) (with yes execution at step S5 in Figure 2), discharge processing of the source liquid material is executed with N_2 as the carrier gas as shown below in place of the dummy vaporization processing at step S6.

[0044]

When discharge processing of the source liquid material is executed, by switching valve (33) to "open" and valve (34) to "closed" and introducing N_2 gas into the source liquid material channel of vaporizer (21) from piping (46), the TMPO inside vaporizer (21) is vaporized and discharged outside vaporizer (21) to be replaced by N_2 gas. The discharged gaseous TMPO (although vaporized, it has not reached the level of the source gas used in reaction chamber (1)) is discharged to waste tank (10) through flow rate meter (30) and "open" valve (7).

[0045]

In this way, with the vapor phase growth device of Embodiment 2, discharge processing of the source liquid material by forcibly introducing N_2 into the source liquid material channel is executed at the state where the amount of oligomer generation will not adversely affect the vaporizer during the period that the vaporizer is left at a high temperature, under the control of device controller (50). So adverse effects on vaporizer (21) that accompany generation of oligomer from the TMPO can be reliably avoided.

[0046]

Note that the TMPO feed path outside vaporizer (21) (the path by which TMPO reaches valve (34) through liquid flow rate meter (27)) is at normal temperature. Therefore, the TMPO in the feed path is a source liquid material at normal temperature, so hardly any hydrolysis occurs. The result is hardly any oligomer generation by the TMPO in the TMPO feed path, and no adverse effects, such as blockage of the vaporizer, occur.

[0047]

Embodiment 3

Figure 5 is a block diagram that shows the constitution of TMPO vaporizing part (52B) in a vapor phase growth device that is Embodiment 3 of this invention. As shown in the figure, an organic solvent feed path composed of valve (34) and valve (36) is additionally furnished for piping (46) that is connected to the source liquid material channel of vaporizer (21). Along with this, valve (34) [sic; (35)] is furnished between liquid flow rate meter (27) and valve (34). Note that the constitution other than inside TMPO vaporizing part (52B) is the same as the constitution of TMPO vaporizing part (52A) of Embodiment 2 shown in Figure 4, and the constitution outside TMPO vaporizing part (52B) is the same as the constitution of Embodiment 1 shown in Figure 1.

[0048]

In a constitution such as this, during normal film formation, processing is performed with a constitution equivalent to the vapor phase growth device of Embodiment 1 with valve (33) "closed," valve (34) "open," valve (35) "open," and valve (36) "closed". /6

[0049]

Then, as in Embodiment 2, at the point where a prescribed time has elapsed after film formation has been completed under the control of device controller (50), valve (33) is switched to "open" and valve (34) to "closed" and N_2 gas is introduced into the source liquid material channel of vaporizer (21) from piping (46) so that the TMPO inside vaporizer (21) is replaced by N_2 gas.

[0050]

In addition, Embodiment 3 supplies an organic solvent to the source liquid material channel of vaporizer (21) by "closing" valve (33), "opening" valve (34), "closing" valve (35), and "opening" valve (36). The result is that cleaning processing can be performed to discharge the residue in the source liquid material channel into waste liquid tank (10) from vaporizer (21) through flow rate meter (30) and "open" valve (7).

[0051]

Embodiment 4

Figure 6 is a block diagram that shows a partial constitution in a vapor phase growth device that is Embodiment 4 of this invention. As shown in this figure, a waste liquid tank (38) is furnished from piping (16) through valve (37). That is, waste liquid tanks on the drain side connected to piping (16) will be of two types: waste liquid tank (10) and waste liquid tank (38). Note that the rest of the constitution inside TMPO vaporizing part (52B) is the same as the constitution of Embodiment 3 shown in Figure 5, and the constitution of portions not shown in Figure 6 is the same as the constitution of Embodiment 1 shown in Figure 1.

[0052]

In a constitution such as this, during normal film formation, processing is performed with a constitution equivalent to the vapor phase growth device of Embodiment 1 with valve (33) "closed," valve (34) "open," valve (35) "open," and valve (36) "closed."

[0053]

Then, as in Embodiment 2, at the point where a prescribed time has elapsed after film formation has been completed under the control of device controller (50), valve (33) of TMPO vaporizing part (52B) is switched to "open" and valve (34) to "closed." Valve (7) is, in addition, "opened," valve (8) "closed," and valve (37) "closed" so that N_2 gas is introduced into the source liquid material channel of vaporizer (21) from piping (46). The result is that the TMPO inside vaporizer (21) is replaced by N_2 gas, and the gaseous TMPO that is discharged outside vaporizer (21) is discharged into waste liquid tank (10) through flow rate meter (30) and "open" valve (7).

[0054]

After this, valve (33) is "closed," valve (34) is "opened," valve (35) is "closed," and valve (36) is "opened." In addition, valve (7) is "closed," valve (8) is "closed," and valve (37) is "opened," to supply organic solvent into the source liquid material channel of vaporizer (21) as in Embodiment 3. The result is that cleaning processing can be performed so that the residue in the source liquid material channel of vaporizer (21) is discharged into waste liquid tank (38) through flow rate meter (30) and "open" valve (37).

[0055]

In this way, with the vapor phase growth device of Embodiment 4, subsequent waste liquid treatment can be accomplished easily by separating the discharge targets for the TMPO, which is

the source liquid material, and the organic solvent, which is the cleaning material, in waste liquid tank (10) and waste liquid tank (38).

[0056]

Embodiment 5

The constitution of the vapor phase growth device of Embodiment 5 is the same as Embodiment 4 shown in Figure 6. However, the control details for the organic solvent by device controller (50) will be different.

[0057]

With the vapor phase growth device of Embodiment 5, during normal film formation, processing is performed with a constitution equivalent to the vapor phase growth device of Embodiment 1 with valve (33) "closed," valve (34) "open," valve (35) "open," and valve (36) "closed."

[0058]

Then, at the point where a prescribed time has elapsed after film formation has been completed under the control of device controller (50), the processing shown in Figure 7 is executed.

[0059]

First, at step S61, the valves are operated as with Embodiment 4 to introduce N_2 gas from piping (46) to the source liquid material channel of vaporizer (21). The result is that the TMPO in vaporizer (21) is replaced by N_2 gas, and the gaseous TMPO discharged outside vaporizer (21) will be discharged into waste liquid tank (10) through flow rate meter (30) and "open" valve (7).

[0060]

After that, at step S62, the valves are operated as in Embodiment 4 to supply organic solvent into the source liquid material channel of vaporizer (21). The result is that the residue in the source liquid material channel of vaporizer (21) is discharged into waste liquid tank (38) through flow rate meter (30) and "open" valve (37).

[0061]

In addition, at step S63, valve (33) of TMPO vaporizing part (52B) is switched to "open, and valves (34) and (36) to "closed." In addition, valve (7) is "closed," valve (8) is "closed," and valve (37) is "opened" to introduce N_2 gas from piping (46) into source liquid material channel of

vaporizer (21) and the organic solvent is replaced by N_2 gas. In this case, the organic solvent is heated to a high temperature at or above the boiling point with a heater inside vaporizer (21) so that nearly all the organic solvent remaining in the source liquid material channel is discharged outside vaporizer (21). Then the gaseous organic solvent that is discharged outside vaporizer (21) is discharged into waste liquid tank (38) through flow rate meter (30) and "open" valve (37).

[0062]

Application to manufacturing methods

If a semiconductor device manufacturing method for manufacturing a specific semiconductor device is executed using the vapor phase growth devices described with Embodiment 1 – Embodiment 5, no adverse effects on the vaporizer will occur because of changes in the state of the source liquid material left at a high temperature. So higher quality semiconductor devices can be manufactured.

[0063]

Other

Here, with Embodiment 1 – Embodiment 5, vapor phase growth devices that react ozone and a source gas that is an organic source with a normal temperature CVD to form an oxide film on a substrate surface were described, but the same effects can also be expected with vapor phase growth devices that use other CVD methods, such as low pressure CVD, or PVD. For example, when PVD is used, flow rate regulators (23)-(25) may be omitted and the processing details by /7
reaction chamber (1) with the constitution in Figure 1 may be changed. For the replacement gas, N_2 gas was described, but the same effects can be expected by using another inert gas, such as Ar.

[0064]

Effect of the invention

As explained above, the semiconductor manufacturing device mentioned in Claim 1 in this invention will execute forced vaporization processing to forcibly vaporize a source liquid material when the period in which the vaporizer has not generated a source gas reaches a prescribed time.

[0065]

Therefore, by setting the aforementioned prescribed time during the period when the vaporizer has not generated source gas to a shorter time than the time in which the source liquid material will change to a state that will adversely affect the vaporizer, adverse effects on the vaporizer that occur due to a change in state of the source liquid material inside the vaporizer during a period in which the vaporizer has not generated a source gas can be reliably avoided.

[0066]

The semiconductor manufacturing device mentioned in Claim 2 avoids adverse effects on the vaporizer that occur due to a change in state of the source liquid material during a period in which the vaporizer has not generated source gas by vaporizing the source liquid material in the vaporizer to generate source gas when the period in which the vaporizer has not generated source gas has reached a prescribed time.

[0067]

The semiconductor manufacturing device mentioned in Claim 3 avoids adverse effects on the vaporizer that occur due to a change in state of the source liquid material during a period in which the vaporizer has not generated source gas by discharging the source liquid material in the source liquid material channel inside the vaporizer outside the vaporizer while it is being vaporized when the period in which the vaporizer has not generated source gas has reached a prescribed time.

[0068]

The semiconductor manufacturing device mentioned in Claim 4 cleans out the source liquid material remaining in the source liquid material channel by executing source liquid material cleaning processing after forced vaporization processing has been executed to reliably avoid adverse effects on the vaporizer that occur due to a change in state of the source liquid material during a period in which the vaporizer does not generate source gas.

[0069]

The semiconductor manufacturing device mentioned in Claim 5 will make subsequent waste treatment easy by separating the discharge targets for the source liquid material and the cleaning material into first and second discharge parts.

[0070]

The semiconductor manufacturing device mentioned in Claim 6 can effectively discharge the cleaning material by executing cleaning material discharge processing.

[0071]

The semiconductor manufacturing device used in the semiconductor device manufacturing method mentioned in Claim 7 has no adverse effects on the vaporizer that occur due to a change in state of the source liquid material during a period in which the vaporizer does not generate source

gas, so the precision of the manufacturing process for the aforementioned semiconductor device can be improved and higher quality semiconductor devices can be manufactured.

Brief description of the figures

Figure 1 is a block diagram that shows the constitution of a vapor phase growth device that is Embodiment 1 of this invention.

Figure 2 is a flowchart that shows the control details by the device controller of Embodiment 1.

Figure 3 is a graph that shows the control details by the device controller of Embodiment 1.

Figure 4 is a block diagram that shows the constitution of the TMPO vaporizing part in a vapor phase growth device that is Embodiment 2 of this invention.

Figure 5 is a block diagram that shows the constitution of the TMPO vaporizing part in a vapor phase growth device that is Embodiment 3 of this invention.

Figure 6 is a block diagram that shows the partial constitution of a vapor phase growth device that is Embodiment 4 of this invention.

Figure 7 is a flowchart that shows a part of the control details by the device controller of Embodiment 5.

Figure 8 is a block diagram that shows the constitution of a conventional vapor phase growth device (film formation device).

Figure 9 is a cross section that shows the internal constitution of a vaporizer.

Figure 10 is a graph that shows states of the vaporizer shown in Figure 9.

Figure 11 is a graph that shows the relationship between oligomer (polymer) concentration and the time period that TMPO remains at high temperature.

Explanation of symbols

(10), (38) Waste liquid tank, (20)-(22) Vaporizer, (32) Fluid regulator (MFC), (33)-(36) Valve, (50) Device controller, (52A), (52B) TMPO vaporizing part.

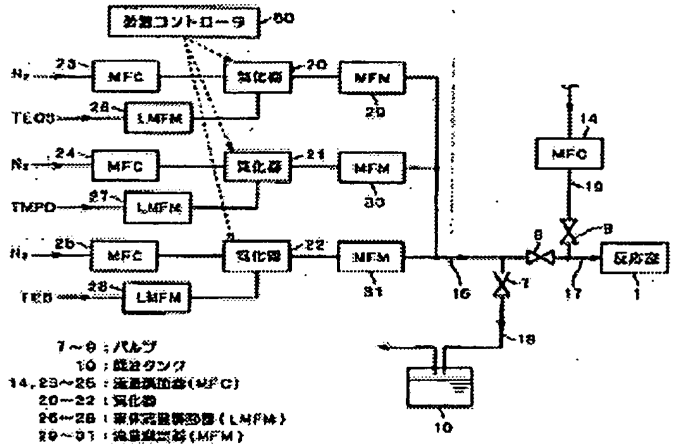

Figure 1

Key: 1 Reaction chamber
20-22 Vaporizer
50 Device controller

Legend:	7-9	Valve
	10	Waste liquid tank
	14, 23-25	Flow rate regulator (MFC)
	20-22	Vaporizer
	26-28	Fluid flow rate regulator (LMFM)
	29-31	Flow rate meter (MFM)

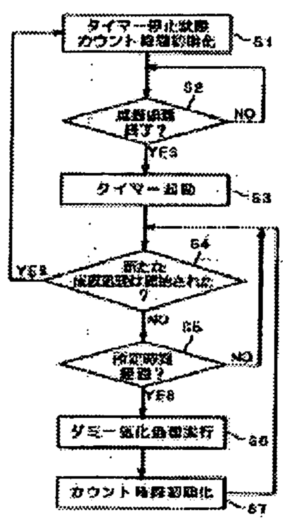

Figure 2

Key: S1 Timer stopped
Count time initialization

S2 Film formation completed?
S3 Timer activation
S4 New film formation started?
S5 Prescribed time elapsed?
S6 Dummy vaporization processing execution
S7 Count time initialization

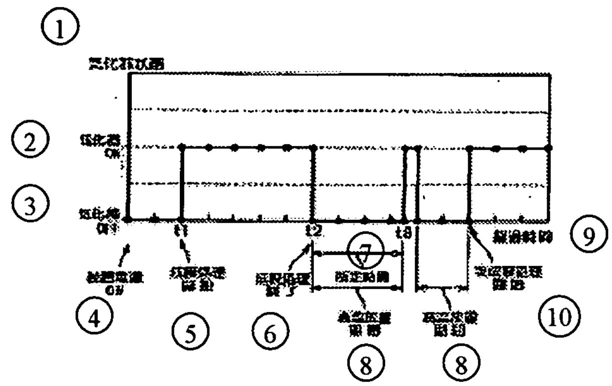

Figure 3

Key:
1 Vaporizer state
2 Vaporizer on
3 Vaporizer off
4 Device power on
5 Film formation start
6 Film formation completion
7 Prescribed time
8 Period left at high temperature
9 Elapsed time
10 Next film formation start

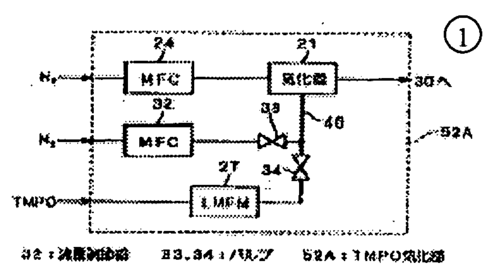

Figure 4

Key:
1 To (30)
21 Vaporizer

Legend: 32 Flow rate regulator
33, 34 Valve
52A TMPO vaporizing part

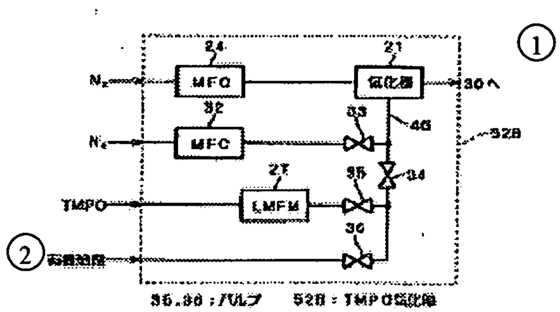

Figure 5

Key: 1 To (30)
2 Organic solvent
21 Vaporizer

Legend: 35, 36 Valve
52B TMPO vaporizing part

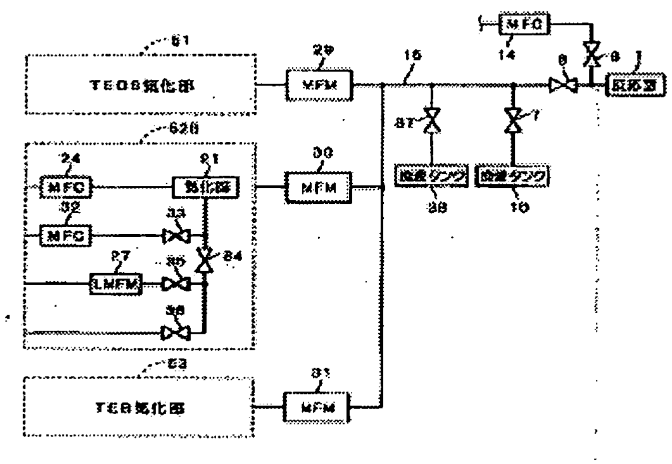

Figure 6

Key: 1 Reaction chamber
10 Waste liquid tank

21 Vaporizer
38 Waste liquid tank
51 TEOS vaporizing part
53 TEB vaporizing part

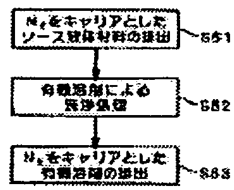

Figure 7

Key: S61 Discharge of source liquid material with N_2 as carrier
S62 Cleaning processing with organic solvent
S63 Discharge of organic solvent with N_2 as carrier

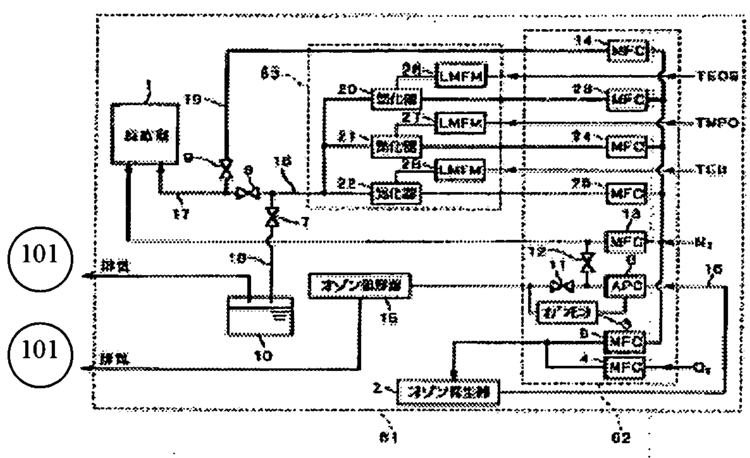

Figure 8

Key: 1 Reaction chamber
2 Ozone generator
3 Ozone monitor
15 Ozone processor
20-22 Vaporizer
101 Exhaust

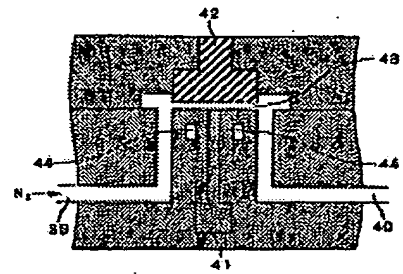

Figure 9

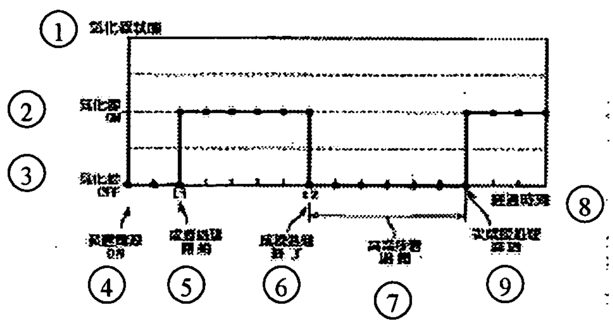

Figure 10

Key:
1 Vaporizer state
2 Vaporizer on
3 Vaporizer off
4 Device power on
5 Film formation start
6 Film formation completion
7 Period left at high temperature
8 Elapsed time
9 Next film formation start

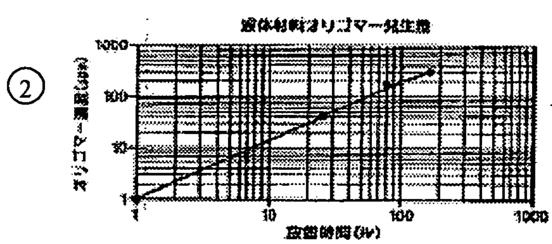

Figure 11

Key:
1 Liquid material oligomer generation amount
2 Oligomer concentration
3 Time